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Certified by

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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☐ *Additional inventors are being named on the _____ separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

FUSION-CAST ZIRCONIA REFRACTORY WITH HIGH ELECTRICAL RESISTIVITY

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☑ Specification *Number of Pages* 5

☐ Drawing(s) *Number of Sheets*

☑ Application Data Sheet. See 37 CFR 1.76

☐ CD(s), Number

☑ Other (specify) EXPRESS MAIL CERTIFICATE; RETURN RECEIPT POSTCARD

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fees

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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

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☐ Yes, the name of the U.S. Government agency and the Government contract number are:

Respectfully submitted,

SIGNATURE _____

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Date 01/02/2004

REGISTRATION NO. *(if appropriate)* 46,305

Docket Number: 1457 US/PRO

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

This collection of information is required by 37 CFR 1.51. The information is used by the public to file (and by the PTO to process) a provisional application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the complete provisional application to the PTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, D.C. 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Box Provisional Application, Assistant Commissioner for Patents, Washington, D.C. 20231.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	)	WINDER et al.
	)	
Title	)	FUSION-CAST ZIRCONIA
	)	REFRACTORY WITH HIGH
	)	ELECTRICAL RESISTIVITY
	)	
Attorney's Docket	)	1457 US/PRO

To: Mail Stop PROVISIONAL PATENT APPLICATION
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FUSION-CAST ZIRCONIA REFRACTORY WITH HIGH ELECTRICAL RESISTIVITY

Field of the Invention

The present invention relates to fusion-cast zirconia materials, and in particular a fusion cast zirconia refractory having high electrical resistivity suitable for use in glass-melting furnaces.

Description of the Related Art

Fused refractories comprising primarily ZrO_2 ("zirconia") are traditionally used in glass melting furnaces. The zirconia provides excellent corrosion resistance to the molten glass. Refractories utilizing Al_2O_3-ZrO_2-SiO_2, known as AZS refractories are well known in the art. Such refractories that have a ZrO_2 concentration of 80 wt % or higher are referred to as high-zirconia fused refractories.

It is desirable, especially in the production of high-quality glasses, such as TFT-LCD glass and plasma display panels, that the refractory used in the glass melting furnace have high electrical resistivity. It is also generally desirable that the refractory provides superior resistance to corrosion and thermal cycling.

High-zirconia fused refractories have been disclosed, for example, in U.S. Patent Nos. 5,466,643 to Ishino, et al. (the "643 Patent") and 5,679,612 to Endo, et al. (the "612 Patent"), the entire contents of both of which are hereby incorporated by reference. The '643 Patent discloses a fused zirconia refractory that utilizes 0.05 to 1.0% of P_2O_5 in order to soften the matrix glass. Though this refractory exhibits an acceptable level of electrical resistance, its main objective was to improve the thermal cycling resistance and

it does so by increasing the total amount of the glassy phase, which may decrease the corrosion resistance of the refractory. The '612 Patent discloses a fused zirconia refractory that eliminates the use of P_2O_5, but adds in 0.05 to 3% of BaO, SrO and MgO in total, in order to reduce the stresses on the glassy phase of the refractory that are caused by the elimination of P_2O_5. The '612 Patent further discloses the use of Na_2O (in an amount greater than .05%) and K_2O to reduce the tensile stress that is caused by the addition of the alkaline earth metal oxides listed above. The presence of Na2O and K2O, in dissimilar amounts, may not provide the most optimized electrical resistance in the refractory.

Therefore, the present invention seeks to achieve high electrical resistance in the fused zirconia refractory, while minimizing the concentration of BaO, SrO, MgO, CaO, P2O5, Na2O and K2O.

Summary of the Invention

In order to achieve the listed objectives, a fusion-cast refractory is provided. The refractory comprises 0.8% to 2.5% Al_2O_3, 4.0% to 10.0% SiO_2, 86% to 94% ZrO_2, 0.1% to 1.2% B2O3, up to 0.04% Na_2O, up to 0.4% CaO, up to 0.1% Fe_2O_3 and up to 0.25% TiO_2.

Detailed Description of the Preferred Embodiments

Except where otherwise noted, all percentages listed below, including in any claims, are on a weight basis and are a percentage of the fusion-cast refractory. The present invention is a fusion-cast refractory comprising 0.8% to 2.5% Al_2O_3, 4.0% to 10.0% SiO_2, 86% to 94% ZrO_2, 0.1% to 1.2% B_2O_3, up to 0.04% Na_2O, up to 0.4% CaO, up to 0.1% Fe_2O_3 and up to 0.25% TiO_2. Refractories made in accordance with the

present invention are characterized by an electrical resistivity of at least 80 ohm-cm at 1625°C.

In a preferred embodiment, the present invention is a fusion-cast refractory comprising 0.9% to 2.0% Al_2O_3, 6.0% to 8.0% SiO_2, 88% to 92% ZrO_2, 0.3% to 0.9% B_2O_3, up to 0.04% Na_2O, up to 0.2% CaO, up to 0.05% Fe_2O_3 and up to 0.15% TiO_2.

The ZrO_2 content of the refractory according to the invention is 86 to 94%, and preferably is 88 to 92%. ZrO_2 content higher than 94% does not offer crack-free refractories, while ZrO_2 content lower than 86% leads to poor resistance to molten glass.

The SiO_2 content of the refractory according to the invention is 4 to 10%, or preferably 6 to 8%. The glass phase cannot be formed as a continuous matrix phase at a content of less than 4%, while poor resistance to molten glass may be expected at a content of higher than 10%.

The Al_2O_3 content of the refractory according to the present invention is 0.8 to 2.5%, and preferably 0.9 to 2.0%. Al_2O_3 improves the flowability of the melt at a content higher than 0.8%, but content higher than 2.5% leads to instability of the glass phase, rendering the product prone to failure.

The B_2O_3 content of the refractory according to the present invention is 0.1 to 1.2%, and is preferably 0.3 to 0.9%. The addition of B_2O_3 aids in suppressing cracks in the refractory during fabrication. This benefit is not realized at a content of less than 0.1%, and concentrations over 1.2% can cause an anomalous behavior of the glassy phase.

CaO is an optional component of the refractory according to the present invention, and is present in an amount from 0.0 to 0.4% of the refractory. The CaO may

be added in order to help reduce the stresses in the refractory and to reduce cracking during fabrication. The addition of CaO is also beneficial when the refractory of the present invention is used in a glass melting furnace where TFT-LCD glass or plasma display panels are formed, as those molten glasses may also contain CaO.

Na_2O is also an optional component of the refractory according to the present invention, and is present in an amount from 0.0 to 0.04% of the refractory. The Na_2O is a preferably eliminated from the refractory, as Na_2O is the major source of electrical conduction in the glass.

TiO_2 and Fe_2O_3 may be present as impurities, but their individual concentrations should not exceed 0.25% for the TiO_2, 0.1% for the Fe_2O_3, and the total concentration should not exceed 0.35% because they may increase the defect-forming potential of the refractory.

Obviously, numerous modifications and variations of the present invention are possible. It is, therefore, to be understood that within the scope of the following claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A refractory comprising 0.8% to 2.5% Al_2O_3, 4.0% to 10.0% SiO_2, 86% to 94% ZrO_2, 0.1% to 1.2% B2O3, up to 0.04% Na_2O, up to 0.4% CaO, up to 0.1% Fe_2O_3 and up to 0.25% TiO_2.

Application Data Sheet

Application Information

Application Type:	Provisional
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Request for Early Publication?:	No
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Suggested Drawing Figure:	None
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Representative Information

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Domestic Priority Information

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None			

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None			

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